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Ecological, Economic and Marketing Aspects of the Application of Biofertilisers in the Production of Organic Food

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1. Introduction

Having ability to produce on his own necessary products, man has become independent of nature and its generosity. By this ability man provided for instance his independent development within nature. Due to the further development of his knowledge he managed to elevate the production to the level of the science and therefore to aim many processes towards the desirable direction. Today, there are no more or less important plant species, but only more or less important technology of their production. Crop yield expressed through the gain/profit, which is anyway an ultimate objective of the production, depends, first of all, on the investments into the production. Fertilisation is one of very important cultivation measures. The application rate of mineral fertilisers can be distributed in the soil in the determined concentrations, which is their advantage over biological nitrogen. Nitrogen mineral fertilisers are more soluble and due to their greater solubility they are more accessible to plants as plants consume much less energy when they absorb easy available nitrogen forms. However, in order to obtain high yields, mineral fertilisers, especially of nitrogen ones, are often applied in the agricultural production. It is considered that the application of mineral fertilisers is the most advantageous and the fastest way to increase crop yields. The significance of the application of mineral fertilisers in the crop production in the European Union (EU-15) is confirmed by the records made in 2001: out of the totally applied amount of 15,286,903 t, 4,178,000 t were applied in France; 589,717 t in Ireland; 1,405,913 t in Italy; 416,000 t in the Netherlands; 2,613,413 t in Germany, etc. (www.fao.org). On the other hand, only 272,000 t of mineral fertilisers were applied in Serbia (www.poljoprivreda.info). The structure of the mineral fertiliser application in Serbia is unsatisfactory and presents a problem as complex and more expensive NPK fertilisers are used in smaller amounts, while the use of nitrogen fertilisers is much greater. Namely, 63%, i.e. 37% of the total use of mineral fertilisers were related to nitrogen, i.e. NPK fertilisers, respectively.

Plants use 40-50% of nitrogen incorporated by mineral fertilisers, then, soil microorganisms transform 15-20 % of nitrogen fertilisers into gaseous compound, while 20-30% are integrated into the soil organic matter. The remaining amounts of nitrogen are leached or can be involved into metabolism of effective microorganisms and in such a way they can inhibit the development of beneficial soil microorganisms.

It must not be forgotten that some adverse effects of high application rates of nitrogen fertilisers can occur in the nutrition chain of man. Young plants have no ability to transfer great amounts of incorporated nitrogen into proteins and other organic forms. The nitrogen surplus can be accumulated in green parts of plants, which can be reduced in digestive organs into nitrites and carcinogenic nitrosoamines that can induce general toxicosis. Moreover, a share of nitrates in the surplus is leached into deeper layers and causes pollution of aquatic basins. The application of high rates of nitrogen mineral fertilisers results in the disturbance of the natural equilibrium in grasslands by the alteration of their floristic composition. Results obtained in many studies show that under influence of these fertilisers a participation of grasses has been increasing while the participation of legumes has been decreasing. The unilateral use of higher rates of nitrogen fertilisers decreases the contents of sugar and starch in sugar beet, the oil content in oil crops, then it prolongs the growing season, affects wheat lodging and reduces grain yield in maize, leads to the modification of the floristic composition of weed associations. Nitrogen fertilisers are the most dangerous mineral fertilisers from the aspect of pollution of the environment (Marchner & Römheld, 1992). In addition, mineral fertilisers are relatively expensive – they are approximately five-fold more expensive than biological nitrogen. High rates of nitrogen mineral fertilisers can alter agrochemical properties of the soil. Their application during a longer period of time can lead to the increase of salts in the soil, can change pH of the soil solution, can lead to a change of soil biogeny and of those microbes that are important for soil fertility. Besides, growers seek any possible way to reduce the production costs, i.e. cost prices of all agricultural products so that their products can be competitive in local and global food markets (Cvijanović, D. et al. 2001).

Microbes have the most important role in the matter and energy cycle in the soil and take significant part in biodiversity conservation. The change in biodiversity, defined as a change within the living world of a certain ecosystem, is a good indicator in protection. The soil is a complex system in which the majority of biological processes occur due to microorganisms. Control of soil microorganisms with the aim to provide optimum conditions for the crop production means the following:

a. monitoring of microbiological activity (abundance, enzymic activity and biodiversity);
b. the relation between beneficial and pathogenic microorganisms;
c. the application of beneficial and effective microorganisms as inoculates in order to direct certain processes.

The intensive use of chemicals in the conventional agricultural production is one of the factors that affect the reduction in biodiversity, nitrogen leaching, soil and water contamination with pesticides, nitrites and heavy metals. Soil, as a very important agricultural resource for any country, is not any more of a non-limiting area as it used to be, hence a great attention has to be paid to the soil management and utilisation. National strategies of conservation and protection of nature and biodiversity have been implemented in many European countries (Nielsen & Winding, 2002). Soil, i.e. ecosystem control action guidelines were presented in The Sixth Environmental Action Programme „Environment 2010: Our Future, Our Choice" (Hubert et al., 2001).

On the other hand, growers have the following very positive effects and multiple benefits from the application of microbiological fertilisers in the crop production (Subić et al. 2006):

- yield increase;
- possibility to reduce the application of mineral fertilisers;
- profit increase;
- conservation of the soil as a limiting resource necessary for food production.

The aspect of how and in which way we should protect not only regions in which the food is produced, but the complete environment that is necessary for plants, animals and man is especially important (Katić B. et al. 2005). It can be achieved by reducing all inputs that lead to the endangerment of soil, water and air, and whereby of plants, animals and man. Microbiological fertilisers are the appropriate approach and a mode of maintaining and increasing of obtained yields of all crops with the reduction of the mineral fertilisers application.

The significant aspects of this issue are contemporary market trends that change marketing activities (which are essentially economic ones) towards the ethic, human and **ecological aspect**. As a rule, developed markets are in developed countries with customers who have become choosy due to their incomes, i.e. with consumers who have become aware of the fact that they use ecological products and healthy food. There are significant natural resources (first of all soil and water) in our country that are not polluted and therefore provide real possibilities for the production of healthy and safe, i.e. organic food (Cvijanović, D. et. al. 2001b).

2. A Possible Application of Biofertilisers as Microbiological Fertilisers

Soil microorganisms are very heterogeneous and the most abundant group that makes the soil a very complex and dynamic system. The abundance, activity and diversity of microorganisms are considered a significant indicator of a potential and effective soil fertility. Based on the knowledge of functions of certain groups of microorganisms, microbiological processes that are significant for the plant growth and the soil health can be directed towards a desirable direction (Milošević et al. 2004, 2006, Cvijanović G. et al. 2005). Studies and utilisation of microorganisms and their metabolic processes for the crop production optimisation provide a long-term conservation of soil qualities. Therefore, the application of microbial inoculates as biofertilisers, stimulators or biocontrols of phytopathogens in the food production, satisfies the concept within the system of sustainable agriculture: stability and quality of yield, maintenance of the ecological equilibrium that is reflecting on both, health safety of food and economic effect. The application of the information gained within the filed of biological nitrogen fixation means the application of effective microorganisms (that fix atmospheric nitrogen *Rhizobium/ Bradyrhirizobium, Azotobacter, Azospirillum,* bacteria of the genus *Bacillus, Pseudomonas*, blue-green algae *Nostoc*, *Anabaena* and mycorrhizal fungi) as inoculates that increase the soil biological activity and quality of field and vegetable crops (Milošević & Jarak, 2005). Genetically modified species do not encompass the mixture made of effective microorganisms. The soil species, that are an integral part of microbial niches, encompass this mixture. Biological fixation is a significant and interesting process not only in a biological, but also in a practical sense. According to studies carried out by Babeva & Zenova (1989) the amount of 160-190 $kgN.ha^{-1}$ is annually fixed in the biosphere in the process of biological nitrogen fixation. A total of 80% of nitrogen is fixed within the microbial system, while 7% within these 80% are fixed in the association of diazotrophs and non-leguminous plant species. Nitrogen, accumulated in the soil in such a way, is not only cheap, but it is also harmless, as it is in a form of organic compounds and it is accumulated during the growing season.

Pure cultures of microorganisms are applied in the plant production in the form of microbiological fertilisers. The microbiological fertiliser for soybean encompassing the highly-effective strains *Rhizobium/Bradyrhizobium japonicum* has the greatest application. The initial attempts of the application of the symbiotic bacteria as a microbiological fertiliser in Germany dates as far back 1896 (more concrete: legumes were treated; non-legumes were treated much later, i.e. in 1923). The application of symbiotic bacteria has started spreading in other regions and today it is a compulsory measure, especially for soils on which soybean has not been previously grown. Moreover, the application of selected active strains of symbiotic nitrogen fixing bacteria resulted in higher yields (3.662 kg.ha^{-1} JUS – macro trial, Agroinstitut, Sombor, 2005), higher protein content (34.55% – macro trial, Agroinstitut, Sombor, 2005), reduction of nitrogen mineral fertilisers utilisation (60 kgN.ha^{-1} replacement for approximately of 130kg UREA - macro trial, Agroinstitut, Sombor, 2005). By such an application of this fertiliser, soybean should be treated as stubble with 30 kgN.ha^{-1}, as a low level of nitrogen allows recognition and infection of roots. In soils well supplied with nitrogen, nitrogen mineral fertilisers are not applied in the production. Over 200 kgN.ha^{-1} could be fixed in a symbiotic association with other plant species (other legumes, clover, alfalfa). Plants in the association with symbiotic bacteria can satisfy up to 80% of their nitrogen requirements. The effect of plant inoculation depends on a plant species, applied agro-amelioration treatments, soil types and bacterial species (Bashan and Levanony, 1990).

Studies on and the application of non-symbiotic, associative biofertilisers were increasingly distributed in the practice during the last decades of the previous century. The application of associative nitrogen fixing bacteria (*Azotobacter, Azospirillum, Derxia,* etc.) in the production of wheat, maize, sugar beet, sunflower and some vegetable crops, indicates to the possibility of replacement of up to 60 kgN.ha^{-1} (Govedarica et al. 1997), or even up to do 150 kgN.ha^{-1} (Dőberainer, et al. 1972) depending on a strain. Particularly good results of the application of associative biofertilisers were obtained in the production of nursery plants of vegetable crops, which matured faster and more uniformly after replanting (tomato leaf area – approximately three times greater; pepper leaf area – approximately two times greater; tomato stalk length – greater by approximately 14 cm; pepper root length – greater by about 40%; tests carried out by Jugoinspekt, Belgrade, 2006).

In the countries of eastern Asia, a microbiological fertiliser with blue-green algae *Nostoc* and *Anabena*, that are able to bind atmospheric nitrogen in the amount of up to 20-30 kgN.ha^{-1} annually, is used in the production of rice and cotton. If a microbiological fertiliser without supplements of mineral nitrogen is applied, the rice yield can be increased by 33% (Venkataraman, 1981), as it produces many biologically active growth substances. Great amounts of biomass remain after harvest; hence by the application of this fertiliser the content of a organic part of the soil is increased. Bacteria and fungi capable to supply plants with phosphorus are also very important as biofertilisers. Bacterium *Bacillus megaretium* var. *phosphaticum* is able to supply plants with phosphorus as it is capable to mineralise phosphorus in the organically bound form, and therefore it is recommendable for the use in soils rich in phosphorus. Previous results show that this fertiliser cannot replace mineral phosphorus fertilisers, but it should be a growth stimulator. Mišustin & Emcev (1987) assumed that a stimulatory effect of *Bac. megaterium* could be explained by the ability of the bacterium to extract active growth substances (thiamine, pyrodoxine, biotin, nicotinic acid, B_{12}), hence it can be recommended as a growth and development stimulator of field crops.

The benefit of the application of microbiological fertilisers can be of a great importance for both, growers and processors (Subić et al. 2006). If we take sunflower as an example (macro trial, Institute „Tamiš" Pančevo, 2005):

1. grower's benefit:
   -the average yield increase (+35 €.ha^{-1});
   -the average reduction of mineral fertilisers (+6.5€.ha^{-1});
   -the average profit increase (+38 €.ha^{-1});
   -plus effect on the soil;
2. processor's benefit:
   -the average increase of crude oil (+5 %);
   -the average profit increase (+12 €.t^{-1} processed raw material);
   -plus transport and storage savings, as well as, a greater amount of raw material.

Hence, the application of associative nitrogen fixing bacteria has a multiple significance for the yield increase, lowering of mineral fertiliser rates, profit increase, as well as, a positive effect on the soil.

The application of biofertilisers is the unavoidable future and therefore a rational and efficient utilisation of mineral fertilizers can be provided by combination with microbiological preparations.

3. Significance of Biological Nitrogen Fixation in Agriculture

Experimental and theoretical studies on the effects of plant inoculation with nitrogen fixing bacteria are economically and ecologically justified for their broad application and commercialisation as microbiological fertilisers. These fertilisers can be liquid, solid, wet and powdered after lyophilisation of strains. The effect of an inoculate depends on the applied agro-amelioration treatments, soil types, plant species, species and strains of nitrogen fixing bacteria, cell concentration in the preparation, the mode of preparation (Wani et al. 1994). Preparations encompass effective microorganisms that can be applied as single or a mixture of strains of one or more species. According to Higa (1991), effective microorganisms contain selected species of microorganisms including dominant populations of bacteria, actinomycetes, fungi and others. All applied species or strains have to be compatible in a liquid culture that is used as an inoculate. The effect of certain strains or species can hardly be determined by the application of inoculates with mixed species or strains of the same species. If such inoculates are based on the principles of a natural ecosystem, or if, due to their abundance and efficiency, their starting position is better than the position of the autochthons population, then their effectiveness will be great.

According to results gained by Burns, 1995, Bachan & Levanony, 1990, biofertilisation with associative nitrogen fixing bacteria showed a positive effect in the production of non-leguminous plants:

- maize;
- wheat;

- sugar beet;
- potato;
- tobacco, as well as, other vegetable crops.

Studies on the application of *Azotobacter, Azospirillum*, *Derxia, Klebsiella, Pseudomonas* and others as biofertilisers in the production of the most important field crops (maize, wheat, sugar beet and sunflower) show that they can, depending on the strain, mode and the form of the application, replace from 20 to 60 kgN.ha^{-1}. Plant inoculation with associative nitrogen fixing bacteria and phosphorus as mineralisers significantly increases yields and biomass of field crops (Govedarica et al., 1997a) and productive and technological quality of sugar beet (Mrkovački et al. 2007) and resistance to phytopathogens (Burns, 1995). The application of biofertilisers provide plants with an easier intake of phosphorus and potassium, absorption of active growth substances and vitamins, auxins, gibberellins produced by biofertilisers, hence it is their advantage over chemical fertilisers. Professor Dr. Mitar Govedarica initiated studies on the application of associative nitrogen fixing bacteria in field and vegetable crops in Serbia. This author also gave the greatest contribution to studying of their effects on yield and quality of filed crops, as well as, on elements of soil biogeny. Inoculation of wheat seed shows a positive effect on a spike length (7-30%) and a number of fertile spikelets (12-25%) (Govedarica, et al. 2001). Inoculation with *Azotobacter chroococcum* led to the increase of maize yield, while the effect depended on the strain, hybrids and the amount of applied NPK fertilisers. Long-term studies point out to a positive effect of different stains of *Azotobacter chroococcum* on grain yield of maize and applied rates of 60 kgN.ha^{-1}, indicating to a possibility of a replacement of a certain amount of nitrogen mineral fertilisers (Cvijanović, G. et al. 2005., 2006.) According to Doberenier (1997), there is a possibility to replace 30% of mineral nitrogen with biofertilisers and certain amounts of phosphorus and potash fertilisers.

The profitability of the application of microbiological fertilisers could be best observed in the model with maize and sunflower (studies were carried out during 2005):

1. macro trial, „Agroinstitut", Sombor:
   -hybrid (ZP 680);
   -number of plants (54,400);
   -moisture (32.4%);
   -content of total proteins (8.46%);
   -grain yield at 14% moisture (12,648 kg.ha^{-1});
   -average yield increase (+288 kg.ha^{-1});
   -average profit increase (+216 €.ha^{-1});
2. macro trial, Institute „Tamiš", Pančevo:
   -hybrid (Velja);
   -yield (3,654 kg.ha^{-1});
   -moisture (13.3%);
   -admixtures (1.8%);
   -oil content (43.86%);
   -yield JUS (3,567 kg.ha^{-1});
   -average yield increase (+221 kg.ha^{-1});
   -average profit increase (+414.3 €.ha^{-1}).

Long-term studies were performed on slightly calcareous chernozem in the experimental field of the Maize Research Institute, Zemun Polje at Zemun Polje in the vicinity of Belgrade. The effect of associative biofertilisers on quality and quantity of yields of maize hybrids of

various FAO maturity groups (FAO 600-700 and FAO 300-400), then on fundamental parameters of soil biogeny at different rates of nitrogen mineral fertilisers was observed. The seed was treated immediately prior to sowing with inoculates that encompassed the same amounts of different highly efficient strains of the following species *Azotobacter chroococcum, Azospirillum lipoferum, Brijerinckia Derx, Klebsiella planticola, Azotobacter vinelandi, Pseudomonas Bacillus magaterium* and *Bacillus subtillis* at the fertilisers rates of 60, 80, 90, 120, 150 and 160 kg N. ha^{-1}. All cropping practices were performed on optimum dates with high quality.
Results show a positive effect of biofertilisers on the level and stability of yield of maize of both maturity groups. The highest yield (9.84 $t.ha^{-1}$ - 13.62 %) was recorded in hybrids of FAO 600-700 in the variant with bacterisation and fertilising with 80 $kgN.ha^{-1}$. Yield was increasing with the increase of mineral nitrogen rates over 80 $kg.ha^{1}$, while it was decreasing, i.e. increasing in the variant with, i.e. without bacterisation, respectively.

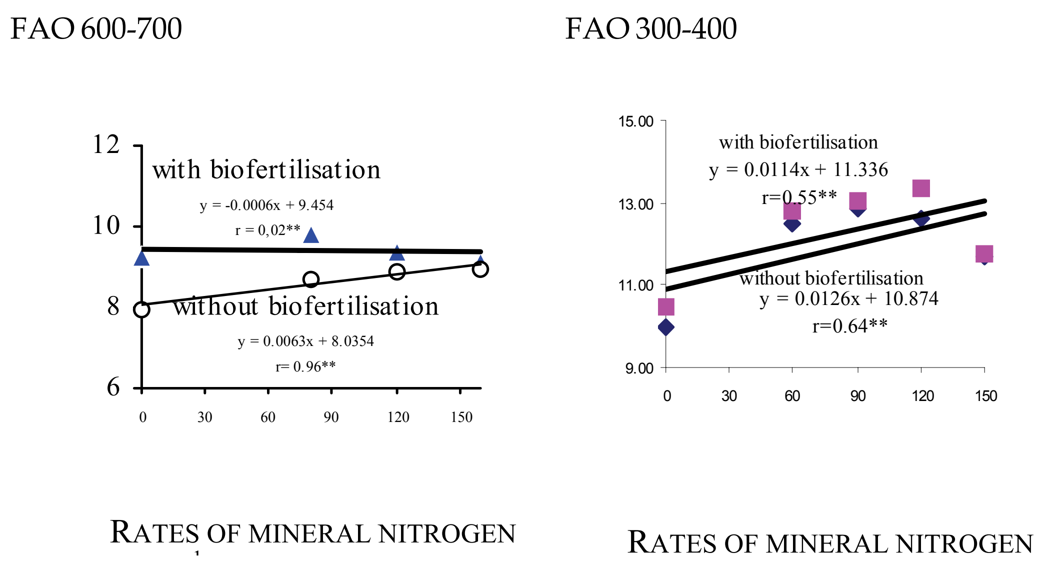


Fig.1. Dependence of maize hybrid yields on the application of biofertilisers, bacterisation and rates of mineral nitrogen

The three-year average grain yield of hybrids of FAO 600-700 over all fertiliser rates amounted to 9.36 $t.ha^{-1}$ at 14% moisture, which was higher by 8.58%, i.e. 740 $kg.ha^{-1}$ than the yield recorded in the variant without bacterisation. The two-year average grain yield of hybrids of FAO 300-400 over all rates of fertilising amounted to 12.29 $t.ha^{-1}$, which was higher by 3.02%, i.e. 360 $kg.ha^{-1}$ than the yield recorded in the variant without bacterisation. The increase of the growth and quality of plant production is a refection of supremacy of beneficial microorganisms. A regression line in obtained yields in both hybrids grown on chernozem (Figures 1 and 2) shows that the yield was significantly higher in the variant with bacterisation and fertiliser rates of 80 and 120 $kgN.ha^{-1}$ and that the yield could be stabilised at a high level. According to the performed correlation analysis it can be stated that a correlation of maize yield and higher rates of mineral nitrogen including bacterisation was highly significant. The regression line in the obtained yield in the variant without bacterisation is in accordance with studies carried out by Vesković (1989) who did not record higher maize yields with rates of mineral nitrogen above 100 $kg.ha^{-1}$, and who determined that nitrogen rates higher than 135 $kg.ha^{-1}$ adversely affected maize yields.

Mode of bacterisation	Proteins	Fertiliser rates $kgN.ha^{-1}$				Average
		0	80	120	160	
Inoculated	%	8.87	9.44	10.07	9.98	9.59
	Index level	110.32	108.00	109.10	109.19	109.22
Uninoculated	%	8.04	8.74	9.23	9.14	8.78
	Index level	100.00	100.00	100.00	100.00	100.00
	LSD 5%	LSD 1%				
Inoculation **	0.176	0.269				
Inoculation x Fertilisers**	0.188	0.274				

Table 1. Effects of bacterisations on total proteins in maize grain

Long-term studies (Cvijanović, G. 2002) on effects of inoculation with biofertilisers show the identical effect on the maize grain protein content and applied rates of mineral nitrogen. Due to its high energetic value, maize is all over the world, including Serbia, mainly used as feed. Although, maize grain proteins lack two amino acids (lysine and tryptophane), they do however provide approximately 20% of total proteins in mixtures, hence the mode of its increase is very important from the ecological aspect. Based on obtained results it is noticeable that maize seed bacterisation led to the increase of the content of total maize grain proteins. This increase, on the average, amounted to 9.22%, so the content of total proteins in the variant with bacterisation amounted to 9.59%, which is very important, as the maize grain protein content ranges from 6 to 12% (Table 1).

According to long-term results it was determined that mineral fertilisers had significantly affected the dynamics of abundance of systematic groups under conditions of bacterisation in the rhizosphere of both hybrids of different maturity groups (Tables 1 and 2). A total number of microorganisms is a good parameter for the soil evaluation. This number increased in the variant with bacterisation at each fertiliser rate in hybrids of both maturity groups. As for the abundance of *Azotobacter* a considerable decrease of their number was observed under high rates of mineral nitrogen. The decrease of the *Azotobacter* abundance in hybrids of FAO 600-700 in the variant with 160 $kgN.ha^{-1}$ was lower by 10.81 % than in the control variant, which led to the decrease of the number on the average over all rates of fertilising by 0.33 %. However, their long-term application result in the decrease of the *Azotobacter* abundance. Due to its susceptibility, this important species of nitrogen fixing bacteria very vigorously responses to changes in the environmental conditions by lowering its number. High rates of mineral nitrogen cause disturbance of the equilibrium of microbiological processes in any soil, and the activity of the majority of beneficial microorganisms is reduced. The reduction of the enzymic activity of microorganisms occurs due to the fact that the level of mineral nitrogen determines the induction of the expression of the gene regulating the nutrient uptake. Furthermore, great amounts of mineral nitrogen inhibit the process of free nitrogen fixation, as they adversely affect the enzyme nitrogenase, which is also caused by lowering the number of this group of nitrogen fixing bacteria.

Fertilisers kgN.ha^{-1}	Total number of microorganisms		Number of *Azotobacter*-a		Dehydrogenase activity	
	$10^7.g^{-1}$soil	Index level	$10^1.g^{-1}$soil	Index level	µgTPF.g^{-1} soil	Index level
0	153.80	100.00	168.21	100.00	438	100
80	159.20	103.51	181.58	**107.94**	481	**109.81**
120	162.22	**105.47**	171.76	**102.11**	460	105.02
160	166.50	**108.25**	150.04	89.19	463	105.70
Average	162.60	105.72	167.66	99.67	468	106.84

Table 2. Effects of bacterisation and fertilisers on parameters of soil biogeny in rhizospheres of maize hybrids of FAO 600-700

The analysis of gained results indicates certain regularity in the increase of their number at low rates of mineral nitrogen. The highest number and the percentage of the increase were determined at fertiliser rates of 80-120 kgN.ha^{-1}. Beside the total number of microorganisms and *Azotobacter,* a dehydrogenase activity is also an important parameter of soil biogeny. The greater value of dehydrogenase points out to faster proceeding of oxidoreduction processes in the soil, that is to faster and greater mineralisation of fresh organic matter. The highest values of dehydrogenase and the percentage of increase were determined in the variant with bacterisation and a fertiliser rate of 80 kgN.ha^{-1}, which correlate to previous two parameters. Based on the statistical analysis of results gained over years it can be concluded that the total number of microorganisms was significantly increased in the variant with bacterisation and fertilising, as well as, in the interaction of these two factors.

Fertilisers kgN.ha^{-1}	Total number of microorganisms		Number of *Azotobacter*		Dehydrogenase activity	
	$10^7.g^{-1}$soil	Index level	$10^1.g^{-1}$soil	Index level	µgTPF.g^{-1} soil	Index level
0	245.50	100.00	47.08	100.00	407	100
60	355.08	144.63	174.18	369.46	526	129.17
90	412.05	**167.84**	180.30	**382.39**	438	107.58
120	302.03	123.03	98.12	208.40	440	**108.05**
150	158.63	64.61	57.49	122.18	113	27.64
Average	307.01	125.05	139.29	296.36	379	93.21

Table 3. Effects of bacterisation and fertilisers on parameters of soil biogeny in rhizospheres of maize hybrids of FAO 300-400

Obtained results point out to the compatibility of selected species of nitrogen fixing bacteria in the inoculum, as seed bacterisation favoured the growth and multiplication of introduced diazotrophs, and their enzymic activity which reflected upon the increase of the abundance and enzymic activity of the autochthons microbial community, which presents a good base for the evaluation of the soil productivity. Biofertilisers applied to the soil induce changes in microbiological communities among which competition for space and energy occur. These changes are more pronounced if hydrothermal conditions during the year are more extreme. Based on such results and under the assumption that agro-meteorological conditions match the average year for maize production, higher yields can be expected.

Bacteria synthesising phosphatase (*Bacillus, Pseudomonas, Azotobacter, Enterobacter, Serratia, Streptomyces*) dwell in plant roots and significantly affect mineralisation of phosphorus organic compounds an could be used in the agricultural production as a supplement of phosphorus mineral fertilisers.
According to results, seed inoculation with *Bacillus, Micrococcus, Enterobacter, Pseudomonas, Flavobacterium*, *Serratia* positively affects the length and dry matter weight of the root and the height of above ground plant parts. Also, maize seed bacterisation resulted in the increase of the phosphorus percentage in the root, while the phosphorus content in the above ground parts was at the level of control. All types of phosphorus as mineralisers caused the increase of the phosphorus content in maize plants in the variants with standard rates of nitrogen mineral fertilisers. The increase of over 100% on the average were caused by *Bacillus* (strain 26), *Pseudomonas* and *Flavobacterium*.

Variants	Root length (cm)	Weight (g)	Total P
Control	29.3	0.17	4.02
Bacillus megaterium B. megaterium + Azotobacter chroococcum	32.2-36.7	0.18-0.23	4.01-4.14
	39.6-43.0	0.24-0.29	4.91-5.92

Table 4. Effects of *Azotobacter chroococcum* and *Bacillus megaterium* on maize

According to obtained results it can be concluded that free and associative microorganisms can be successfully used as biofertilisers in the form of microbiological fertilisers. Studies should be, first of all, aimed at the production methods providing high- quality microbiological fertilisers that should encompass effective microorganisms that initiate certain microbiological processes, then should be greatly competitive and supply plants with assimilatives and support their growth. In order to fulfil these criteria, microorganisms are selected, and then studies are aimed at the selection of microorganisams according to a plant genotype.
As selerogical tests showed that symbiotic and some species of free nitrogen fixing bacteria (*Pseudomonas, Arthobacter* and *Azotobacter*) were related, further studies should be aimed at inventing the best combination of symbiotic and associative mixtures in microbiological fertilisers for legumes. Moreover, new studies should be directed at solving problems of inoculation: a) mechanisms of recognition and binding microorganisms to hosts or soil particles; b) a role of plant genotypes and genetic engineering of microbial communities; c) selection of microorganisms; d) new technologies e) possibilities of mixed cultures.

4. Marketing in the Function of Organic Food

It is the indisputable fact that there are agricultural regions that are not at all contaminated or are contaminated at a very insignificant level, i.e. according to all elements of pollution the soils in such regions are significantly bellow a maximum level of pollution and are much less polluted than soils in European countries. According to certain data, 95% of agricultural areas in Europe are not suitable for the production of organic food. Fortunately, our country, except several industrial centres, is a very favourable region for such a production.

As already stated, massive pollution of environments, on one hand, and high standards on the other hand, that are, as a rule, implemented in highly developed countries, lead to a conclusion that the importance of organic food has been increasing and that it will be even more pronounced in the future.

In relation to the application of biofertilisers in the production of organic food, the issue of the marketing orientation of enterprises, farms and growers, i.e. the issue of Serbian organic food entering the "global market" has been becoming very important.

It is a well known fact that our agricultural enterprises, including farms, used to deal and exist (develop) under conditions of socialistic production relations. The business activities of our companies were adjusted to legal-governmental frames of that time.

Under such administrative-centralistic relationships, the aims of companies were to produce sufficient amounts of goods, which would find their way to the markets (Cvijanović D. & Milenković S. 1995). This used to be a principal characteristic of a business orientation of companies, hence these specific relations were the elements of the market, meaning that demands were greater than supplies. Engineers and other technical experts used to have a dominant place and a role within companies, while the production was the most importat function. Other company functions followed the production development, but the attention was not paid to costs and financial effects of such a production.

A marketing business orientation has established with the development and application of scientific and technological achievements within the field of agriculture. The market has become saturated and the importance of consumers has been observe, hence the need to stimulate the demand for the manufactured demands has arisen. In such an orientation, business leaders have become financiers, sales specialists, etc., while engineers and other technical experts lost their supremacy.

The marketing business orientation means that companies pay special attention to needs and wishes of consumers (buyers) and that they try to satisfy them with the lowest costs. As a matter of fact, the business orientation is leaned towards the market with a great competition, meaning that the main issue is to sell not to produce. Therefore, company leaders aim their activities towards buyers and towards forming a strong bond among scientists, financiers and marketing specialists.

It is not easy to introduce the marketing business orientation into an agro-industrial company, especially into our companies that have been operating under special conditions of inner and outer sanctions during the last ten years. In addition, the whole country including agriculture has been lagging behind the technically developed world. An especial problem of our agriculture is a problem of duality and implement of legal frames for the commodity production (Cvijanović, D. 1996).

The marketing business orientation has been introduced step by step. In short terms, it is necessary to maintain and increase the volume of production and sale, while in long terms it is necessary to develop operative marketing, marketing planning, performance and control. Managers should create a critical mass of collaborates and not only followers and those submissive to authorities, meaning the actions should be clear and decisive, while implementing of such an orientation should be flexible,

Regardless of a type of property and a size of a company, the special emphasise should be put on the position and the image of consistence of the marketing business orientation. In other words, it is necessary to determine the strategy of marketing activities so that the company could be competitive in the market (local and especially international one).

Making significant business decisions will be an objective only if they are based on the adequate marketing information. It is not possible to perform a proper marketing analysis, marketing planning & to make a correct business decisions without data on users, competitions, market conditions and all other factors related to business.
The special attention should be paid to the production of organic food, which is as a rule expensive, has a limited market and is produced in the rural regions of each country including Serbia (Cvijanović, D. and Trifunović, B., 1995a)
One of principal methods of gathering information on market business that can be used to plan current and alter the total production is the marketing analysis of each country, and in the case of our country is the analysis of markets in developed countries of Europe, Asia and America.

5. The image of a Company and its Organic Product (OP)

- facts and evaluation of image elements,
- evaluation of some scopes of business of a given company,
- experience gained with organic products and companies,
- information on OP supplied by a company,
- information channels on a company and OP,
- data on consumers of OP produced by a given company,
- evaluation of a company and OP in relation to the competition,
- differences related to a company comparing to other companies in the region,
- opinions of interviewees on the possibilities to improve OP, purchase, offer, advertising, information

6. The Competitor's Image

- evaluation of OP and some other scopes of business of main competitors,
- competitor's position,
- information channels on competitors

7. Evaluation of the Serbian Market for the Products Manufactured by a Given Company

- opinions and standpoints about supplies of OP produced by a given company in our country
- evaluation of the channels of purchasing of raw materials necessary for the OP production.

8. Habits and Needs to Use OP Produced by a Given Company

- needs to use certain types (modalities) of OP,
- habits, expectations and needs related to OP and the company that products such products,
- reasons to chose particular OPs produced by a given company

9. Standpoints Related to the OP Production of a Given Company

- significance of such products in relations to same or similar produces manufactured by a given company or competitive companies,
- standpoint related to the improvement of the production within the analysed field.

In order to actually recognise set goals it is necessary to perform quantitative studies, as parameters obtained in such studies are reliable and valid due to a greater number of interviewees belonging to the target groups relevant from the aspects of a company for which the studies were performed. The meaning of the working methods that are very important in such studies is as follows:

- making a questionnaire,
- training of an interviewer,
- field work,
- data coding and feeding into a computer,
- statistical processing of data,
- analysis of gained results,
- systematisation of results,
- preparation of results,
- oral presentation, and
- writing reports.

If a given company is not able to perform the stated study, then an authorised agency will do it on behalf of a company.

According to all data obtained by our own efforts or efforts of engaged authorised agency we have to have an answer to the question: ”WHERE ARE WE NOW?” and due to it we can much clearer foresee directions of future activities which should enable us to determine “WHERE DO WE WANT TO GET TO?” and to set general guidelines and strategies in order to win wished positions.

The simplest auxiliary method in making decisions at the stage of planning is the S.W.O.T. analysis that makes differences between strengths, weaknesses, opportunities and threats. This analysis helps us to determine:

- a target group in the target market,
- desirable position,
- communication aims,
- unique message,
- message strategies,
- tactics of communication,
- platform of communication, and
- directions of further operations.

This is a method and a model of a future food production development in Serbia that fits into a new European concept that encompasses actions aimed not only at the increase of production and performing agriculture, but also at ecological functions – conservation of biodiversity, socio-economic function (conservation of traditional rural values, cultural inheritance). It means the production, marketing and advertising of microbiological inputs within the production of organic food, as well as, possibilities of export of food produced in such a way in Serbia into European countries.

10. Reference

Babeva, I.P., Zenova, A.R. (1989): Biologija počv. Izd. Moskovkogo univerziteta, Moskva Bashan, Y., Levanony, H. (1990): Current status of Azospirillum inoculation technology: Azospirillum as a hallenge for agriculture. Can. J, Microbiolog., 36, 591-608

Bashan, Y., Levanony, H. (1990): Current status of Azospirillum inoculation techmology: Azospirillum as a challenge for agriculture. Can. J, Microbiolog., 36, 591-608

Burns, R. G. (1995): Enumeration, Survival, and Beneficial Activities of Microorganisms Introduced into Soil. 145-164. In: Huang, P. M., et al., (eds.) Environmental impact of soil component interaction, Metal, Other Inorganics, and Microbial Activities, CRC Pres. Inc. London

Cvijanović, D. i Milenković, S. (1995): Marketing poslovna orijentacija agro-industrijskog preduzeća, Zbornik radova sa simpozijuma Inovacije u agrobiznis menadžmentu, Aranđelovac 16-18. februar 1995. 332.02:65.012 (082) 338.434 (082). 129-135.

Cvijanović, D. i Trifunović, B. (1995a): Marketing semenskog kukuruza i ruralne sredine Srbije, Rad saopšten na Međunarodnom naučnom skupu Vlasinski susreti '95", 06-08. septembra 1995. Objavljen u časopisu za ruralni razvoj "Viđenja", Beograd. YUISSN 0354-6713, UDK 339.138:633.15 (497.11), 100-109.

Cvijanović, D. (1996): Savremeni marketing u funkciji ekologije, u "Proizvodnja zdravstveno-bezbedne hrane, ekonomsko-ekološki aspekt", Monogr, Novi Sad, mart 1996. CIP 633/635:152(497.11) (082), 103-111.

Cvijanović, D., Mirić, M., Jeremić, M., Kovačević, B., Mladenović, G., i Trifunović, B. (2001): Pariteti i dispariteti cena semena i drugih repromaterijala u našoj poljoprivredi, Časopis „Agroinovacije" YU ISSN 1450-9504, 213-218.

Cvijanović, D. i Mirić, M. (2001a): Odnosi cena semena i ostalih repromaterijala u jugoslovenskoj poljoprivredi, „Agroznanje„ UDK: 339.5.057.7; ISSN: 1512-6412; Tesliću-Republika Srpska (BiH), 13-16.mart 2001.

Cvijanović, D., Dojčinović Nataša i Radović Ljiljana (2001b): Marketing u funkciji proizvodnje zdravstveno bezbedne hrane, (2001): Rad saopšten 14-17. novembra 2001. godine u Subotici, na Međunarodnom simpozijumu: «HRANA U 21. VEKU»; Zbornik rezimea, str. 262-263.

Cvijanović, Gorica (2002): Uticaj diazotrofa na prinos i mikrobiološku aktivnost kod kukuruza, pšenice i soje, Doktorska disertacija; Poljoprivredni fakultet Univerziteta u Novom Sadu

Cvijanović, G., Lalević, B., Milošević, N. (2004): Microorganisms and their significance in the conversation of the agroecological environment, Proceedings Ecoist, 05, Bor 01-04.06.2005. 337-341

Cvijanović, G., Jovanović, Ž., Govedarica, M., Milošević, N., Cvijanović, D. (2005): Ecological and economic effects of the bacterisation application within system of sustainable agriculture, Savremena poljoprivreda Novi Sad Vol. 54, 3-4, UDC: 63(497.1)(051)-"540.2", YUISSN 0350-1205, 115-119,

Cvijanović, G., Milošević, N., Cvijanović, D. (2006): Biological Nitrogen as development function of new fertilizing technology in crop production , Economics of Agriculture Year, 53 Special edition, UDC 631.147:631.847, YU ISSN 0352-3462,39-44

Cvijanović, G., Cvijanović, D., Subić, J. (2006): *„Različiti sistemi đubrenja u proizvodnji kukuruza u funkciji održivosti poljoprivrede i ruralnih naselja"*. Ekonomika poljoprivrede, Год./Vol. LIII, бр./N^0 3 (525-934). UDC 338.43:63, YU ISSN 0352-3462, UDK 631.895:633.15, str. 903-914.

Döberenier,J., Day, Y. M., Dart, P. J. (1972); Nitrogenase activity and oxygen sensivity of the Paspalium notatum-Azotobacter paspalli association J. Gen. Microbiol. 71., No 1, 103-106

Govedrica, M., Milošević, N., Jarak, M. (1997): Biločka azotofiksacija u poljoprivredi: Mogućnost primena i perspektiva, Zbornik radova Naučnog instituta za ratarstvo i povrtarstva Novi Sad, No 29. 27-35.

Govedarica, M., Milošević, N., Jarak, M., Jeličić, Z., Protić, R. (1997a): Diazotrophs and their Activity in Maize and Wheat, Biological Nitrogen Fixation for 21st Century, In: Elmerich et al (eds). Current Plant Science and Biotechnology in Agriculture, Vol. 31, 408 Academic Publish London

Govedarica, M.(2001): Mogućnost primene biofertilizatora u proizvodnji neleguminoznih biljaka Zbornik naučnih radova PKB INI Agroekonomik, 3, 1, 69-76

Higa T. (1991): Effective microorganisms: A biotechnology for mankind. Proceeding of the First International Conference on Kyusei Nature farming Research Center, Atami, Japan, 1-20

Hubert, S. Syed, B., Freudenschuss, A.,Emstsen,V., Loveland, P.- (2001):Propsal for a Europen soil monitoring and assessment framework. Tedhnical report, No 61, Europen Environment Agency, Copenhagen, Danmark

Katić, B., Nikolić Marija i Cvijanović, D. (2005): Zakonodavstvo Srbije u funkciji zaštite životne sredine, Zbornik radova I, ruralni razvoj i zaštita životne sredine, Vlasotince-Vlasinsko jezero, CIP 338.43 (082) 631.95 (082); ISBN 86-902797-2-5; 1-14

Marchner, H., Römheld, V. (1992): Optimieuring der Stickstoffdüngung bei gleichzeitiger Verringerung der Umwltbelastung. Inter.Tagung Optimierung der Stickstoffdungumg. Hohenheim, 187-192

Makro ogled, Agroinstitut Sombor, 2005.

Makro ogled, Institut „Tamiš" Pančevo, 2005.

Milošević,N., Govedarica,M., Cvijanović, G. (2004): Microorganisms as indicators of herbicide effect on biological activity of soil. Acta herbologica, 13, (1), 243-250.

Milošević, N., Jarak, M: (2005): Značaj azotofiksacije u snabdevanju biljaka azotom. U: R. Kastor (ed.) Azot-agrohemijski, agrotehnički, fiziološki i ekološki aspekti, Naučni institut za ratarstvo i povrtarstvo, Novi Sad, 305-352.

Milošević, N., Cvijanović, G., Tintar, B. (2006): Herbicides effects on microbial activity on agricultural soil, Herbologia, ISSN 1840- 0809 Vol. 7, No. 2, 57-71

Mrkovački, N., Mezei, S., Čačić, N., Kovačev, L. (2007): Efekat primene različitih tipova inokulacije šećerne repe, Zbornik radova Naučnog instituta za ratarstvo i povrtarstvo Novi Sad, ISSN 0354-7698, Sveska 43, 201-209

Nielsen, M. N., Winding, A. (2002): Microorganisms as indicators of soil health. National Environmental Research Institute. Technical report, 388, 1-86, Denmark

Primena asocijativnih biofertilizatora u proizvodnji rasada povrtarskih biljaka, Jugoinspekt, Beograd, 2006.

Subić, J., Arsenijević, Đ., Mihajlović, D. (2005): Metode za ocenu održivog razvoja na poljoprivrednim gazdiunstvima. Tematski zbornik „Multifunkcionalna poljoprivreda i ruralni razvoj", Institut za ekonomiku poljoprivrede - Beograd, Departman za ekonomiku poljoprivrede i sociologiju sela Poljoprivrednog fakulteta - Novi Sad, Ekonomski fakultet - Subotica, Društvo agrarnih ekonomista Srbije, Društvo agrarnih ekonomista Srbije i Crne Gore. str. 253-267, CIP 338.43.02(497.1*497.16)(082), COBISS.SR-ID 127317260, ISBN 86-82121-30-1.

Subić, J., Cvijanović, D., Marković, B. (2006): Ocena ekološke održivosti na poljoprivrednim gazdinstvima u opštini Mali Zvornik. Ekonomika poljoprivrede. Tematski broj. Međunarodni naučni skup: Multifunkcionalna poljoprivreda i ruralni razvoj I – razvoj lokalnih zajednica Год./Vol. LIII, бр./N0 TB (13-667). UDC 338.43:63, YU ISSN 0352-3462, УДК 631.95(497.11 Mali Zvornik), str. 57-63.

Tintar, B., Milošević, N., Marinković J., Cvijanović, G. (2007): Mikrobiološka svojstva černozema na različitim lokalitetima u okolini Novog Sada, Zbornik radova Instituta za ratarstvo i povrtarstvo Novi Sad, ISSN 035-7698 Vol. 43., 311-318.

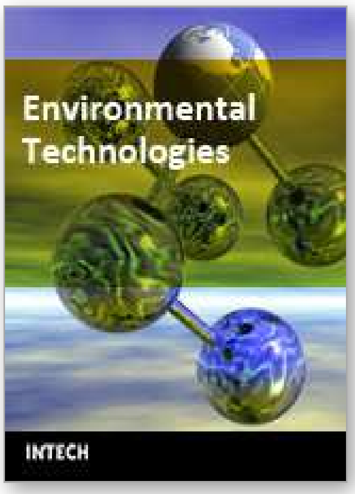
Venkataraman, G.S. (1981): Blue-green algae for rice production-a manual foor its promotion. FAO Soils. Bulletin, 46, Food and agriculture organization on the united nations, Rome, 3-103.

Vesković, M. (1988): Bilans organske materije u zemljištu i prinos kukuruza na černozemun Zemun Polja pri različitim sistemima đubrenja, Doktorska disertacija Poljoprivredni fakultet , Beograd-Zemun

Wani, S.P., Rupela, O.P., Lee, K.K. (1994): BNF Technology for Sustainable Agriculture in the Semi-Arid Tropics. 15th World Congress of Soil Science, Acapulco, 4a, 245-262

www.fao.org

www.poljoprivreda.info



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This book on Environmental Technology takes a look at issues such as air, soil and noise pollution problems, environmental quality assessment, monitoring, modelling and risk as- sessment, environmental health impact assessment, environmental management and envi- ronmental technology development. It represents institutional arrangements, financial mechanisms and some sustainable technologies. The user can always count on finding both introductory material and more specific material based on national interests and problems. The user will also find ample references at the end of each chapter, if additional information is required. For additional questions or comments the user is encouraged to contact the author.